LEISTRITZ Extrusion Technology

At Your Service. Globally.

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Leistritz
EXTRUSION TECHNOLOGY

ELONGATIONAL RHEOMETER

Online measurement of shear and elongational viscosity

MADE IN GERMANY

extruders.leistritz.com

INLINE MEASUREMENT OF THE MELT QUALITY.

Intelligent process monitoring

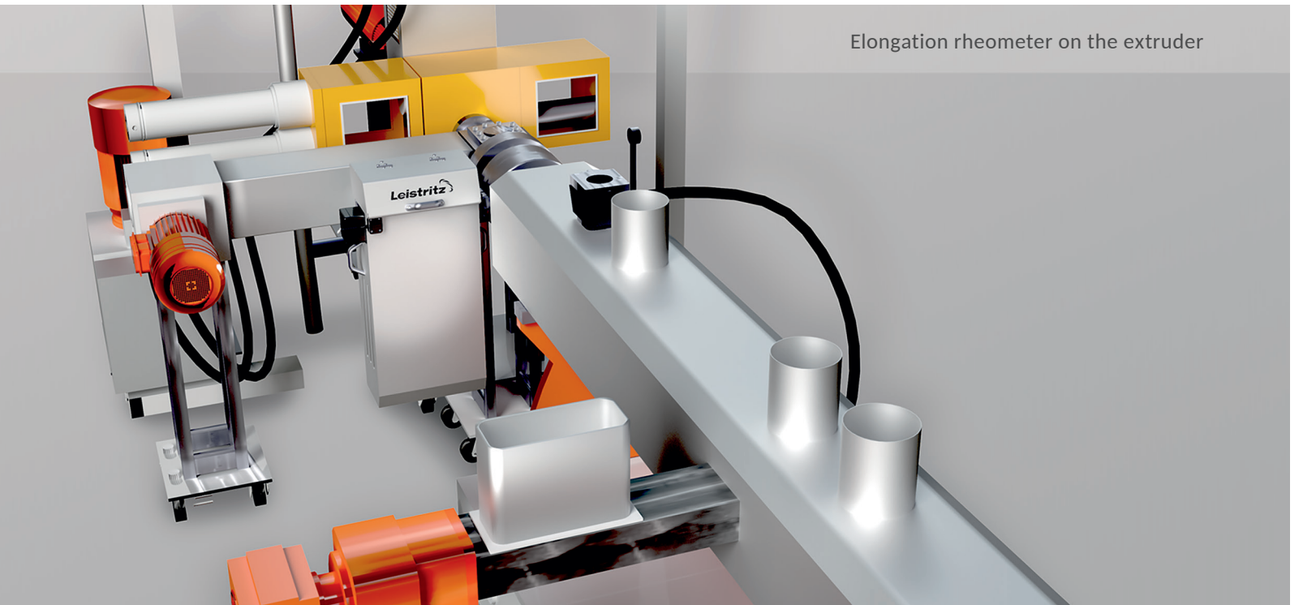
How often does the melt quality drop during a compounding process – without the operator immediately recognizing it? More often than you might think! There are many reasons for quality reduction: Perhaps the polymer or filler used in the extrusion process comes from another batch. Maybe the side feeder was clogged without anyone noticing.
In order to be able to constantly assess the melt quality, the decisive key data must be determined during the process. Up to now, only individual points of the viscosity curve could be determined by means of online measurements (i.e. measurements during the process, without melt return).

More can be done with the Leistritz elongation rheometer: It is the first inline rheometer that combines the measurement of shear and elongational viscosity and also records the data over a defined stress range! The novel measuring system provides well-founded data to detect even the slightest fluctuations during processing.

At a glance

- State-of-the-art rheometer with patented hyperbolic slot die
- Inline measurement of shear viscosity at shear rates from 10 to 10,000 s^{-1}
- Inline measurement of elongational viscosity at elongation rates from 5 to 75 s^{-1}
- Easy integration into any extrusion process
- Two control options: stand-alone or integrated

Fast and reliable:
Full process control with the Leistritz elongation rheometer.



Elongation rheometer on the extruder

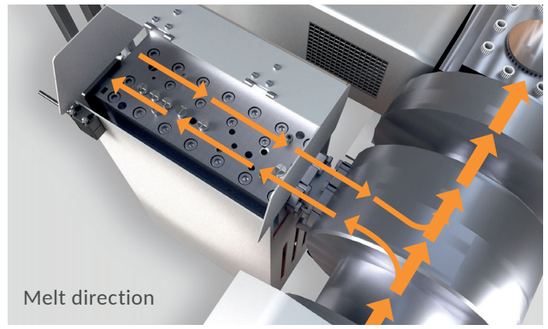
HYPERBOLIC SLOT DIE.

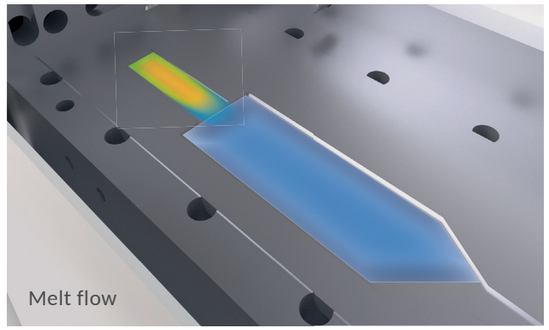
Innovative and patented

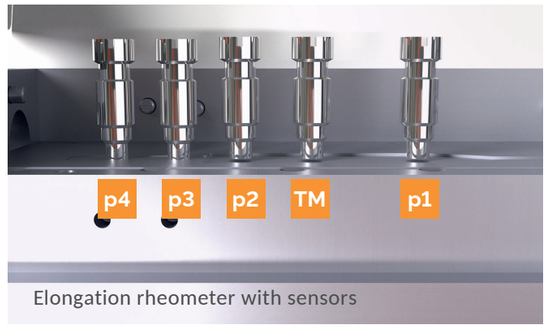
The heart of the Leistritz elongation rheometer is a newly developed and patented slot die. With the help of this slot die geometry a constant elongation flow is generated, which was not possible with previously available online measuring devices. In the continuous measuring process, two shear viscosity values and one elongational viscosity value can be recorded in parallel, within the precisely defined shear/elongation rate range.

Using standard pressure sensors, the elongational viscosity in the flow channel can be determined at constant average elongation rates. The slot die itself consists of a feed section and a discharge section, plus two transition sections. The special configuration of the second transition zone prevents an expansion after elongation, thereby eliminating dead zones or undesirable pressure vortexes in the flow channel. A very precise, electronically controlled melt pump is integrated in order to realize exact volume flows.
During the extrusion process, part of the melt flow is channeled off via a bypass system and passed through the rheometer's slot die. Depending on the polymer, the system allows the material to be returned to the main process so that no material loss occurs.

Measuring range
Due to the selected shape of the slot die, with two parallel zones and a hyperbolic elongation zone, the rheometer is suitable for the online measurement of shear and elongational viscosities at shear rates from 10 to 10,000 s^{-1} and elongation rates from 5 to 75 s^{-1}. Depending on the type of melt pump used, the speed, and the viscosity of the material, the residence time in the measuring device is between one and three minutes. For products with a very low viscosity, the measurement accuracy can be optimized using a melt pump with an increased delivery volume.


Melt direction


Melt flow



Elongation rheometer with sensors

- Mechanically, the new online elongation rheometer can be easily integrated into any extrusion process without major retrofitting.

POSSIBLE APPLICATIONS.

Various compounding processes

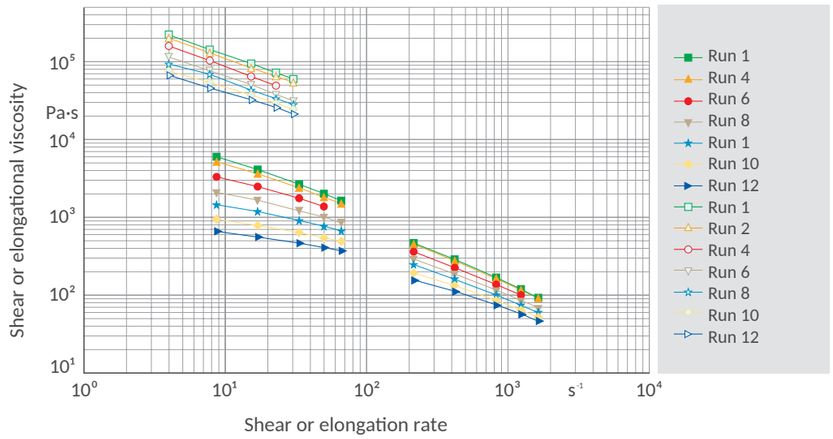
The Leistritz elongational rheometer is a useful further development of measuring instruments for evaluating the melt quality of continuous plastics processing operations. Not only is it suitable for thermally unproblematic polymers using the inline method, but also online for thermally sensitive polymers, because the melt can be discharged after passing through the slot die.
The range of applications extends across all plastics and supports process reliability in the processing of highviscosity pipe compounds as well as in the manufacture of low-viscosity products for fiber and injection molding applications.

Range of application

- with high to low viscosity
- for fiber and injection molding applications
- with glass and natural fibers
- with talcum
- with nanoclays

Polymer preparation

In order to test the degradation reaction of PP pipe material, the material was processed twelve times on a ZSE 27 MAXX twin screw extruder. Thanks to the possibility of inline measurement, the rheometer also opens up new fields of application. Here are a few examples.



Changes in the elongational and shear viscosity curves due to molecular degradation of PP-RA 130E after multiple processing (source: IPEC JKU)

There is a significant degradation of both shear and elongational viscosity. The rheometer could thus be used for inline melt quality testing during the prepartion of polymers.

Evaluate your data INTUITIVELY!

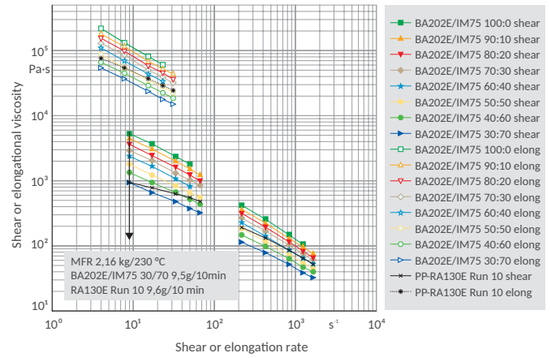
With LinXX Pilot & Rheo - your stand-alone software.

Gain insights into the behavior of extensional and shear viscosity at a glance based on the measurement data from your extensional rheometer.

Find out more: extruders.leistritz.com/en/LinXX

Polymer blend development

To improve, for instance, the low-temperature resistance of high-molecular polypropylene for specific injection molding applications, the materials are frequently blended with impact copolymers. For the development of such blends, different amounts of the two components are usually compounded, followed by an examination of the blend's mechanical parameters. With the help of the Leistritz rheometer, rheological data for further use in the design process can now also be determined during the tests. This permits the process as well as the material to be optimized, since process-relevant data such as shear and elongational viscosities are available.



Shear and elongational viscosity curves of different polypropylene blends during the development of plastic recipes (source: IPEC JKU))

Example: Blending of high molecular PP and free-flowing PP copolymer to improve impact resistance.

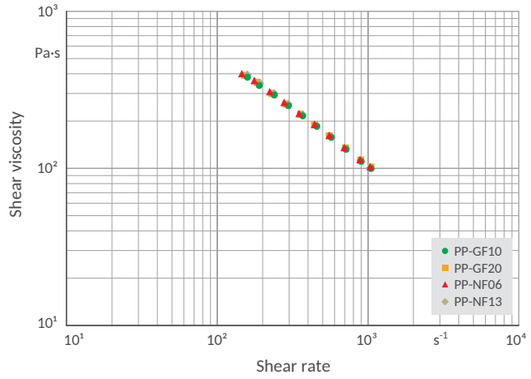
There is a considerable decrease in both shear and elongational viscosity due to the reduction of the proportion of high-molecular polypropylene. Knowing the entire viscosity curve allows a better assessment of the compounding result. Recycled material (after the tenth run) admittedly has the same MFI value, but completely different viscosity curves.

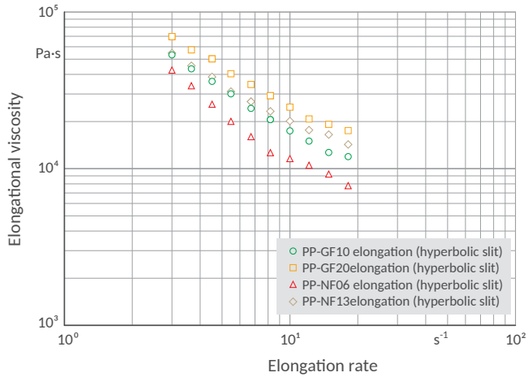
On the basis of elongational viscosity data, better application-specific findings about the processing behavior of plastic melts can be obtained at production-related elongation rates.

Fiber compounds

The elongational viscosity is very sensitive with regard to fiber content and fiber distribution. This is precisely the great advantage of the Leistritz elongational rheometer: It is now possible to use, at the same time, shear viscosity as well as elongational viscosity for the analysis of fiber composite compounds during production.
Example: Compound of a free-flowing PP and cellulose fibers

The deviations between different PP fiber compounds only become apparent when the elongational viscosity is considered. While the evaluated shear viscosities exhibit a basically uniform curve for all samples, the elongational viscosity reveals clear differences in terms of the type as well as the filling content of the fiber.





Online measurement of polypropylene compounds with different amounts of glass fibers and natural fibers. Top: shear viscosity, and bottom: elongational viscosity (source: IPEC JKU)

SOFTWARE AND VISUALIZATION.

Visualization of measurement results

The Leistritz elongation rheometer is available as process monitoring or as research version, with different evaluation and control software: The research version can automatically determine complete elongational and shear viscosity curves by processing a pre-defined volume throughput, and provides direct access to the recorded data. Using this process variant, you can determine the MFR and IV values. In addition, this version enables you to correct the viscosity data according to Weissenberg-Rabinowitsch and Cogswell. With the process monitoring, you can record two values of shear viscosity and one value of elongational viscosity, as well as view the forecast intrinsic MFR or IV value. This means that the process monitoring version can already be effectively embedded into the process control of continuous plastics processing operations.

The software as well as the visualization of the measurement results are available either as part of the Leistritz extruder control system or as a separate stand-alone version.

Description of the different versions with regard to their electrical and control technology

Electrical components	**Stand - Alone**	
	All electrical components, including control panel (19” with Siemens S7 - 1500 control unit), are installed inside a separate control cabinet	
Software versions	**Process-Monitoring**	**Research**
	■ Temperature control (two heating zones: rheometer and pump) ■ Monitoring of fixed speed, torque, throughput, pump blockage and upstream pressure ■ Identifying the apparent shear and elongational rates ■ fixed shear and elongational rates ■ Trend Indicator ■ Mode for determening the melt density ■ Measured data are in csv file formate and can be read out via USB port at given points in time ■ Measured data are transfered between the rheometer and the control via a Profinet coupling	■ the pump speed is controlled variably and the following parameters are evaluated/displayed in addition to the process monitoring functions: volume flow, pressure differences between adjacent measuring points in the nozzle, shear and strain rates varying with the speed, MFR value, IV value ■ Recording of complete viscosity curves possible ■ Measured data are transfered between the rheometer and the control via a Profinet coupling

TECHNICAL INFORMATION.

Technical Data

Drive	
Type of drive	motor-gear combination (DS synchronous servo motor)
Cooling method	fully closed machine, surface-cooled, no fan
Rated power	1,1 kW
Gear ratio	32
IP code	IP54
Rotary encoder type	SINCOS SRS 50 high resolution (1024 periods/revolution)
Max. permissible drive torque	50 Nm
Max. permissible drive speed	50 min^{-1}

Melt pump	
Pump type	spinning pump (gear metering pump)
Product conveyed by the pump	various polymers such as PP, PE, PET, PA, ABS
Operating temperature	up to 350 °C
Permissible cleaning temperature	550°C (without seal)
Delivery volume	1.321 or 2.642 cm^3/revolution
Inlet pressure	10 bar minimum
Max. back pressure	500 bar
Max. differential pressure	450 bar
Material	high-grade W-V-Cr alloy high-speed steel
Melt pressure sensor (5x)	mercury-free / signal 4...20 mA / measuring range 0 - 500 bar
Melt temperature sensor (1x)	type J (Fe-Cu/Ni)
Heating power / heating zones	4.55 kW / 2 heating zones (measuring plates, melt pump)
Supply voltage	380-480 V / PE / 50-60 Hz
System volume	43 cm^3
Weight	40 kg

Special features

- Compact design, shortest possible residence time
- Bypass: Return of the material back to the compounding process (no loss of material) or discharge to the outside, e.g. for density measurement
- Warnings / alarm limits
- Calibration of the pressure transducer
- Casing with flap door and safety switch to the bypass lever
- Can be (easily fitted) to the left and right of the extruder without changing the size of the parts
- Installation of a larger pump possible (if required by application)